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United States
Department of
Agriculture

Forest Service

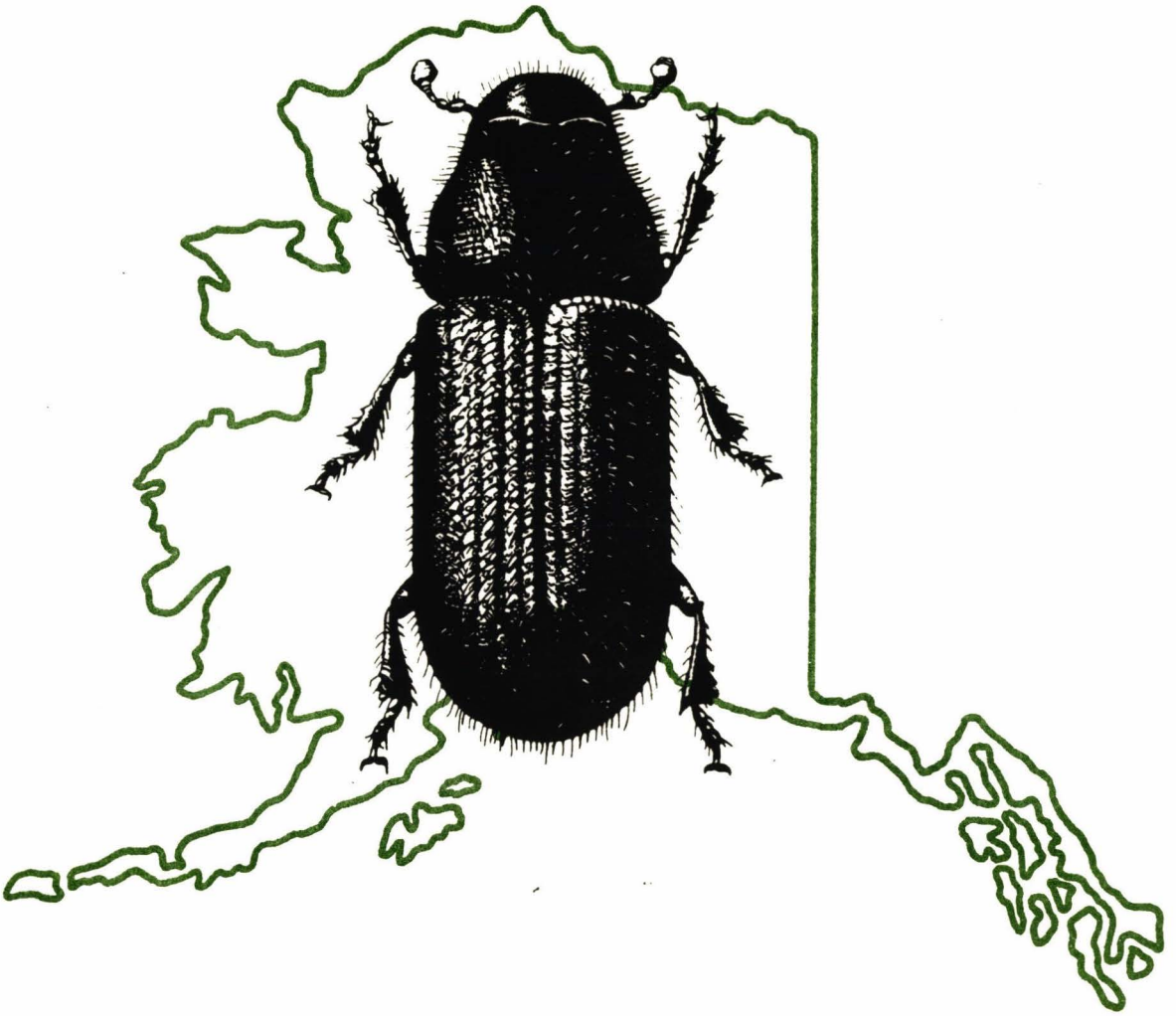
Alaska
Region

Forest Pest Management Report

R-10-87-5

Spruce beetle: Yukon River

October 1987



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BIOLOGICAL EVALUATION R10-87-5

SPRUCE BEETLE-YUKON RIVER

OCTOBER 1987

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INTRODUCTION

The spruce beetle (Dendroctonus rufipennis)(App.A) is one of the most damaging pests of spruce forests throughout North America. Spruce beetles attack all species of spruce from eastern United States to western U.S., as far south as New Mexico and Arizona and, as far north as the Arctic Circle in Alaska (Wood 1982, Bright 1976). In Alaska, bark beetle activity has been most severe south of the Alaska Range. Preferred hosts in Alaska include Sitka (Picea sitchensis), white (P. glauca), and Lutz spruce (P. glauca x lutzii). Black spruce (P. mariana) is rarely attacked. As of 1986, on-going spruce beetle infestations throughout Alaska cover approximately 370,000 acres (USDA For. Serv. 1986).

Spruce beetle outbreaks have not previously been recorded north of the Alaska Range. In interior Alaska, spruce beetles usually occur in down trees or in the lower boles of trees heavily infested by Ips. There have been a few recorded instances of Dendroctonus caused tree mortality in interior Alaska but these occurences were related to on-going Ips outbreaks (USDA For. Serv. 1955, 1959). Ips perturbatus is the prominent tree killer in interior Alaska.

White spruce mortality was detected during Forest Pest Management's 1986 insect and disease aerial survey along the Yukon River south of Galena, Alaska. Scattered mortality was noted east of the Yukon River for 50 miles and encompassed approximately 63,000 acres. An August 1986 ground check revealed spruce beetle as the causal agent, not I. perturbatus as was originally suspected. Evidence of previous flooding throughout the spruce stands was noted during the ground check.

1987 aerial surveys detected 77,154 acres of infested spruce (App. B), an increase of 18% over 1986 infestation levels. Infestations have spread to the

west of the Yukon River and scattered beetle mortality is now noticeable along Bear Creek and the South Fork of the Nulato River (App. B). As this is the first recorded spruce beetle outbreak north of the Alaska Range, an evaluation of the infested area was undertaken by FPM personnel in July 1987. The results are presented in this report.

OBJECTIVES

The objectives of this evaluation are to determine:

1. How much commercial spruce has been killed during the infestation.

2. If interior spruce beetle attack patterns are similar to those of south-central Alaska.

3. If the infestation is increasing, decreasing, or static.

4. Possible causes of the outbreak.

MATERIALS AND METHODS

Sample Sites: Two areas, south of Bullfrog Island and Big Eightmile Island (Fig. 1), were selected for ground evaluation based on their accessibility by floatplane and representativeness of spruce beetle activity as determined by the aerial detection survey.

Stand Composition: Ten variable-radius plots were used to determine stand composition in each study site. A 20-factor prism and a Spiegal Relaskop were used to determine plot trees and tree heights. Plots were established five chains apart. All plot trees were recorded by species and diameter at

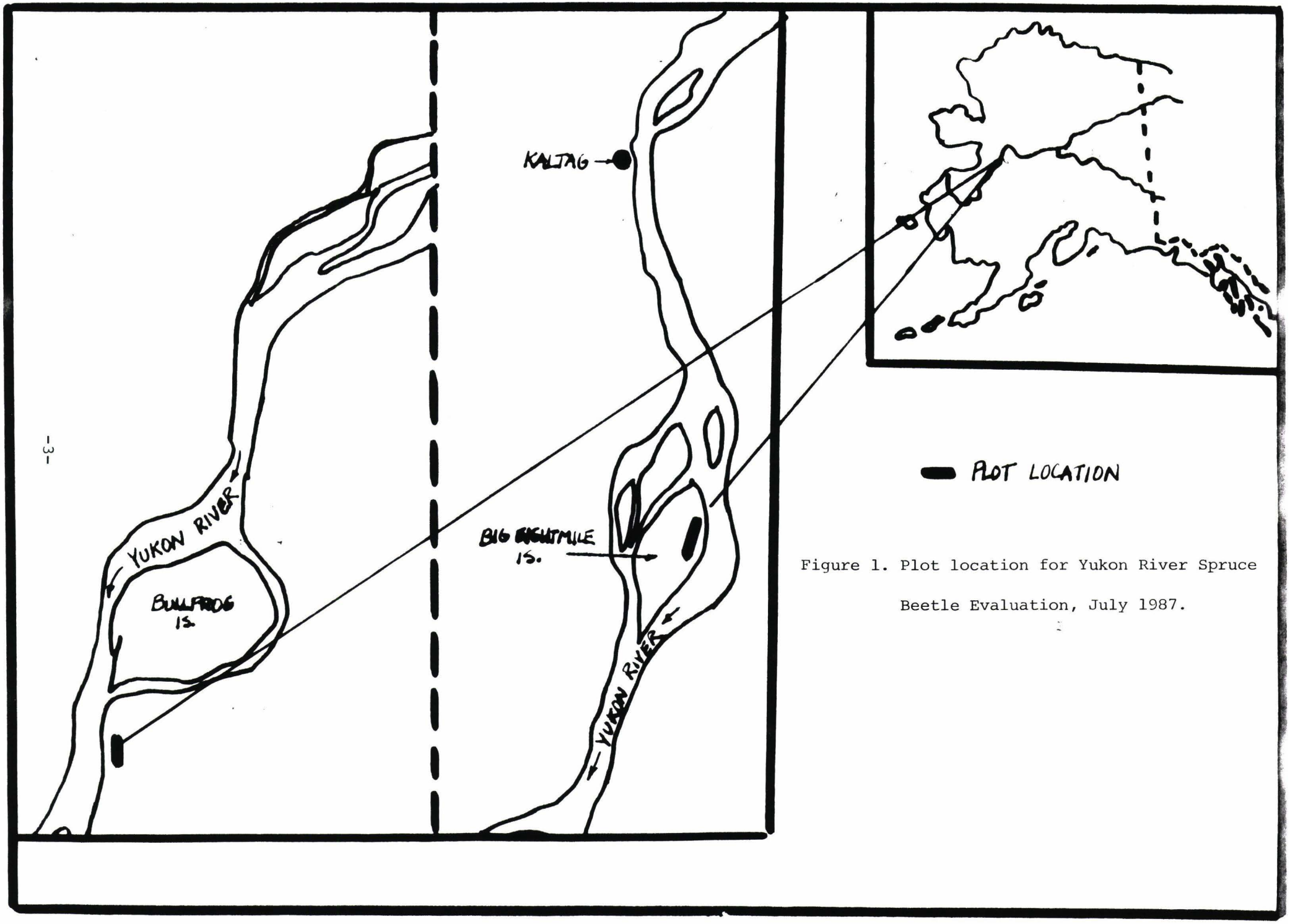

Figure 1. Plot location for Yukon River Spruce Beetle Evaluation, July 1987.

breast height (DBH). Cumulative radial growth in mm for the last five years and age were determined from at least two dominant or co-dominant spruce per plot. The occurrence of blowdown and flooding was noted for each plot.

Spruce Beetle Activity: Within each plot, spruce were classified as either old-attack/dead (the majority of these trees were attacked and killed in 1985-6), new (1987) attack, pitch-out (unsuccessfully attacked), or unattacked/green.

RESULTS AND DISCUSSION

Stand Composition:

Both study sites were comprised predominantely of white spruce (95%) with scattered alder (Alnus sp.), balsam poplar (Populus balsamifera), and willow (Salix sp.). Blowdown was encountered in almost every plot. Most blowdown appeared to have occurred during the last three years. The extensive scattered blowdown was not evident from the air as the willow and alder completely covered the down trees. Signs of previous flooding were not as evident as originally thought to be.

Mean spruce volume (live and dead trees) is 18,559 ± 7,628 and 15,958 ± 8,136 board feet/acre for Bullfrog and Big Eightmile Islands, respectively.[1]

[1] Volume estimates derived from (1) Board-Foot Tree Volume Tables and Equations for White Spruce in Interior Alaska. W.A. Farr. 1967. USFS Res. Note PNW-59, 4pp. in conjunction with (2) Table 1-Stand Factors- from "Log Scaling and Timber Cruising", 1981. J.R. Dilworth. O.S.U. Bookstore, pg. 267.

Mean spruce diameters were similar for both Bullfrog and Eightmile Islands, 16.0 ± 3.5" and 16.4 ± 3.4", respectively. Likewise, mean spruce height and age were similar, 100.2 ± 16.8' and 194.7 ± 46.3 years for the Bullfrog Island area and 98 ± 41' and 159 ± 57.5 years for the Eightmile Island area. Spruce basal area near Bullfrog Island (120 ± 54 ft^2/ac.) was higher than that of Eightmile Island (98 ± 41 ft^2/ac.).

Spruce Beetle Activity and Tree Mortality:

Spruce beetle attacks declined in 1987 over 1986 levels for both areas (Table 1). To date, 44% of the commercial spruce in both evaluated areas have either been killed or were successfully attacked in 1987. Most prior mortality appeared to have occurred in the previous 2-3 years as the bark was still "tight" on the dead trees. Heavier attack levels occurred in the plots south of Bullfrog Island prior to 1987 (43 vs. 25%). This is not surprising as spruce basal area is significantly higher near Bullfrog Island than Big Eightmile Island (120 vs. 98 sq. ft./acre). However, as of 1987, total mortality for the two areas were similar. Approximately 45% of the commercial spruce are currently unattacked. However, these uninfested trees are of sufficient diameter (15")(Table 1) to be susceptible to future spruce beetle attack.

Spruce beetles preferentially attack and breed in slowly growing, large diameter spruce (Schmid and Frye 1976). Hard et al. (1983) showed that on the Kenai Peninsula, diameter is not important for spruce susceptibility to attack unless large diameter is related to slower than average cumulative radial growth in the last five years. As mean cumulative radial growth for spruce for the last five years decreases to 4 mm or less, the incidence of spruce beetle attacks resulting in tree mortality on the Kenai Peninsula increases (Hard et al. 1983, Holsten 1984). Cumulative radial growth data (Table 2) from both

TABLE 1. Diameter, condition, basal area, and volume of spruce affected by spruce beetles in evaluated areas.

AREA	$\bar{x}$ dbh '87 ATT. (in.)	$\bar{x}$ dbh PRE-'87 (in.)	$\bar{x}$ dbh P.O. (in.)	$\bar{x}$ dbh UNINF. (in.)	SPRUCE B.A. sq.ft/ac.	$\bar{x}$ VOL. /ACRE (b.f.)	$\bar{x}$ VOL. KILLED (b.f.)
BULL-FROG IS.	13.7(2%)*	16.7(43%)	19.0(16%)	15.5(40%)	120	18,559	8,352(45%)
EIGHT-MILE IS.	18.1(18%)	17.9(25%)	16.1(10%)	15.0(47%)	98	15,958	6,862(43%)

* Number in ( ) = percent of total trees in a given tree condition class.

TABLE 2. Cumulative radial growth for the previous five years in mm for the evaluated areas as related to tree condition.

	BULLFROG IS.	BIG EIGHTMILE IS.
OLD/ATTACKED DEAD	3.6 (21)*	2.8 (9)
NEW ATTACKS	--	1.8 (6)
PITCHOUTS	3.8 (6)	4.5 (4)
UNINFESTED	4.8 (14)	5.9 (20)
ALL SPRUCE	4.1 (41)	4.4 (39)

* Number in ( ) = number of trees cored.

Yukon evaluation areas follows a similar pattern as the Kenai Peninsula findings. Spruce killed by beetles showed an average cumulative radial growth of only 3.2 mm for the previous five years versus 5.4 mm cumulative growth for the uninfested commercial spruce. These uninfested spruce will undoubtedly come under beetle pressure the next few years. However, their present growth rate is good and should increase due to the thinning effect brought about by the removal (death) of 44% of the spruce overstory. Previous studies on the Kenai Peninsula (Holsten 1987) demonstrated that in heavily beetle impacted areas, live residual spruce showed an average increase in radial growth of 40%. However, as these stands mature and diameters increase, growth rates will decrease. These stands will again become susceptible to spruce beetle outbreaks.

Small populations of spruce beetles are always present in white spruce stands. The number of beetles is usually kept low by parasites and predators of the insect (Werner 1982). However, when conditions are right, spruce beetles may suddenly increase to epidemic proportions. Such conditions include an abundance of breeding material such as blowdown, and a spruce stand characterized by large diameter, slowly growing trees. The current Yukon River outbreak undoubtedly developed in the large amounts of blowdown scattered throughout the infested area. This blowdown provided ample breeding habitat. Also, a large area of the Innoko Wildlife Refuge, including the majority of the beetle infested stands, was under a foot or more of water during an extensive spring flood in 1985. Consequently, the right conditions for an outbreak had developed: (1) Large quantities of blowdown resulting in a large dispersing spruce beetle population over a large geographic area, and (2) spring flooding which may have stressed the already slowly growing, large diameter, old spruce stand. It is anticipated that the current outbreak will cause additional mortality in the infested area as well as in the currently uninfested stands as the beetle population disperses.

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APPENDIX A

Spruce Beetle

Dendroctonus rufipennis (Kirby)
(Coleoptera:Scolytidae)

HOSTS: White, Lutz, Sitka, and rarely black spruce.

DISTRIBUTION: Wherever spruce is found; a serious forest pest in south-central Alaska throughout Cook Inlet and Kenai Peninsula.

DAMAGE: Larvae feed beneath bark, usually killing affected trees.

DESCRIPTION: Adult spruce beetles are dark maroon to black, cylindrical in shape, approximately 5 mm long and 3 mm wide. Larvae are stout, white, legless grubs, 6 mm long when full-grown. The pupae are soft-bodied, white, and have some adult features.

BIOLOGY: The life cycle of the spruce beetle may vary from one to three years, with a two-year cycle being the most common. Temperature plays an important part in determining the length of time required for beetle development.

Adult beetles become active in the spring (late May--early June) when air temperatures reach a threshold of 14.5°C. At this time, beetles emerge from trees in which they overwintered and fly in search of new host material. These dispersal flights may be short-range even though beetles are capable of flying for several miles without stopping.

Spruce beetles prefer to attack the sides and bottom surfaces of windthrows or other down material which have been on the ground less than one year. In the absence of such host material, large-diameter live trees may be attacked instead, and if beetle populations are high, these trees may be killed.

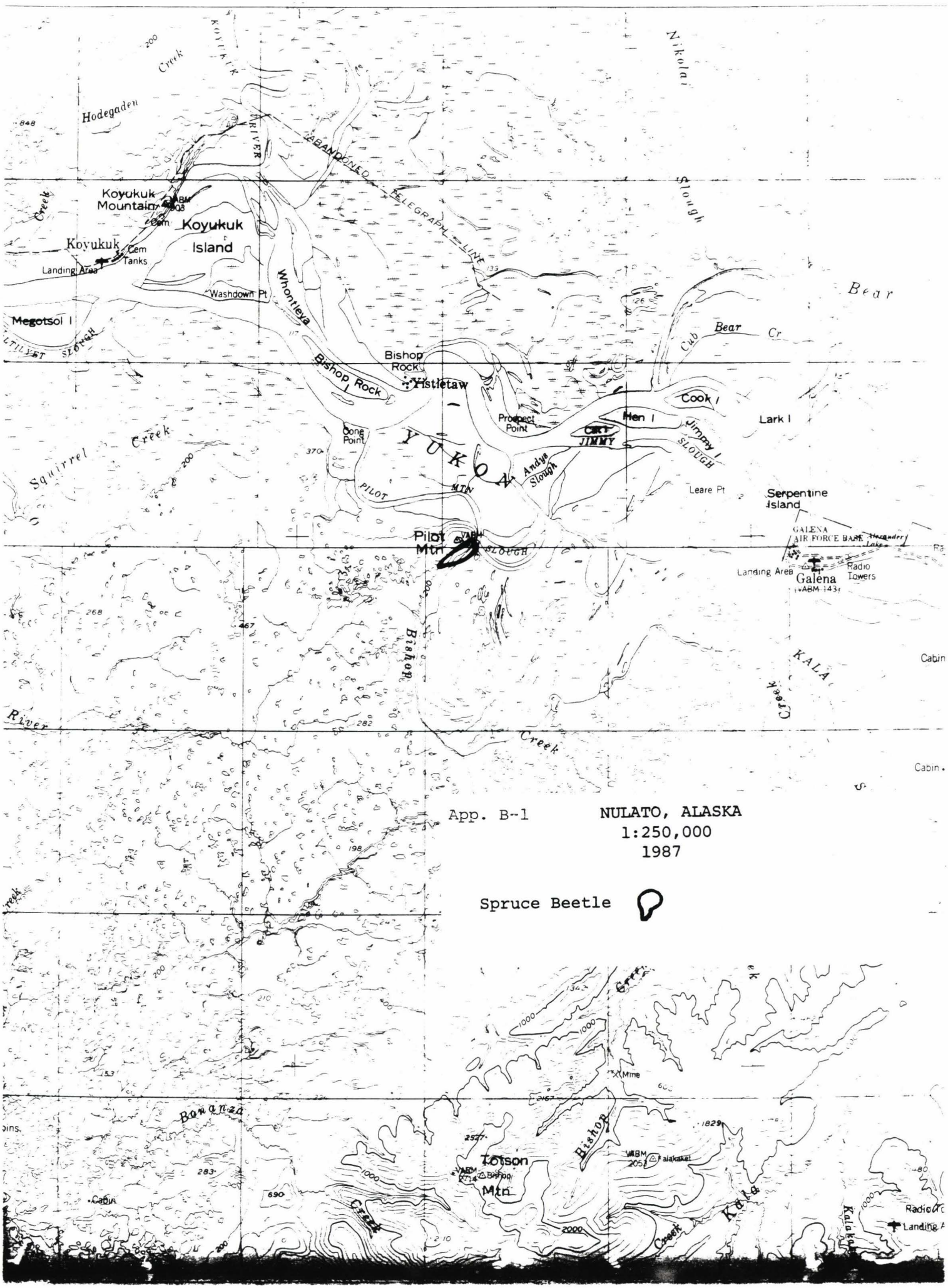
Beetle attacks, whether on windthrows or in standing timber, are mediated by pheromones which insure that individual trees will be attacked "en masse", and fully colonized by subsequent broods. Trees that are mass-attacked form attractive centers which result in groups of trees being killed by spillover attacks.

Female beetles initiate attacks and begin constructing an egg gallery in the cambium parallel to the grain of the tree. They are joined by males and after mating, lay eggs in small niches along the sides of the egg gallery. Most eggs will hatch by August.

As they feed in the cambium, larvae construct their own galleries perpendicular to the egg gallery. Normally, spruce beetles will pass the first winter in the larval stage, resume feeding the next spring, and pupate by next summer. About two weeks later, pupae transform into adults which will pass the second winter, either in the old pupation site, or more commonly, in the bases of infested trees. The following spring, two years after the initial attack, the new adults emerge and disperse to new hosts. When spring and summer temperatures are high, or on certain warmer microsites, spruce beetles may complete their development within one season and new adults will emerge one year after attack.

Virtually all major spruce beetle outbreaks have originated from stand disturbances--blowdown, logging, or right-of-way clearance (Wygant and LeJeune 1967). Stand susceptibility to beetle attack is influenced by stocking, with slow growth and moisture stress playing an important part in predisposing trees to attack.

Appendix B:1-9. Yukon River-1987 Spruce Beetle Infestations. Maps are arranged from Galena south along the Yukon River to Holy Cross.



App. B-1

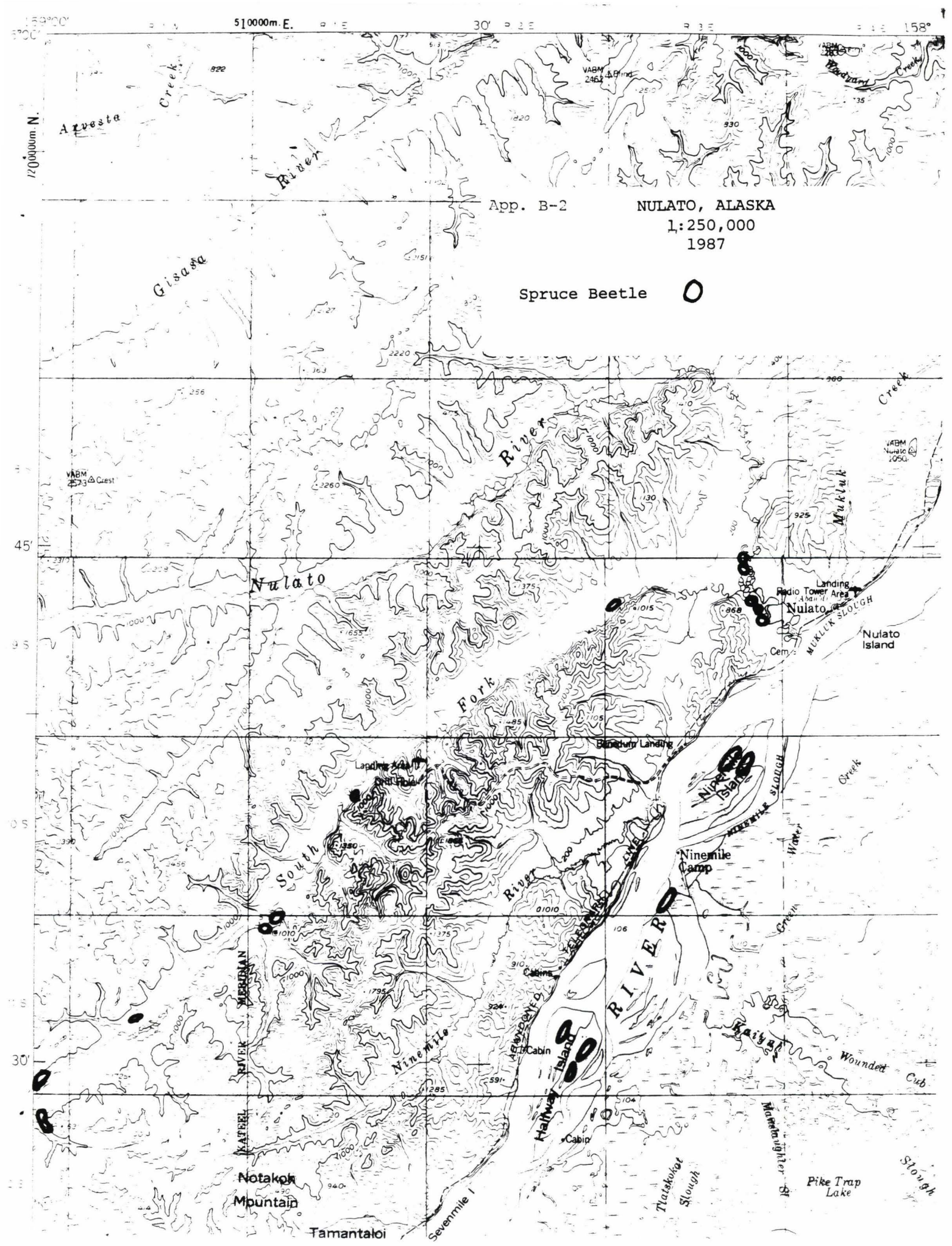
NULATO, ALASKA
1:250,000
1987

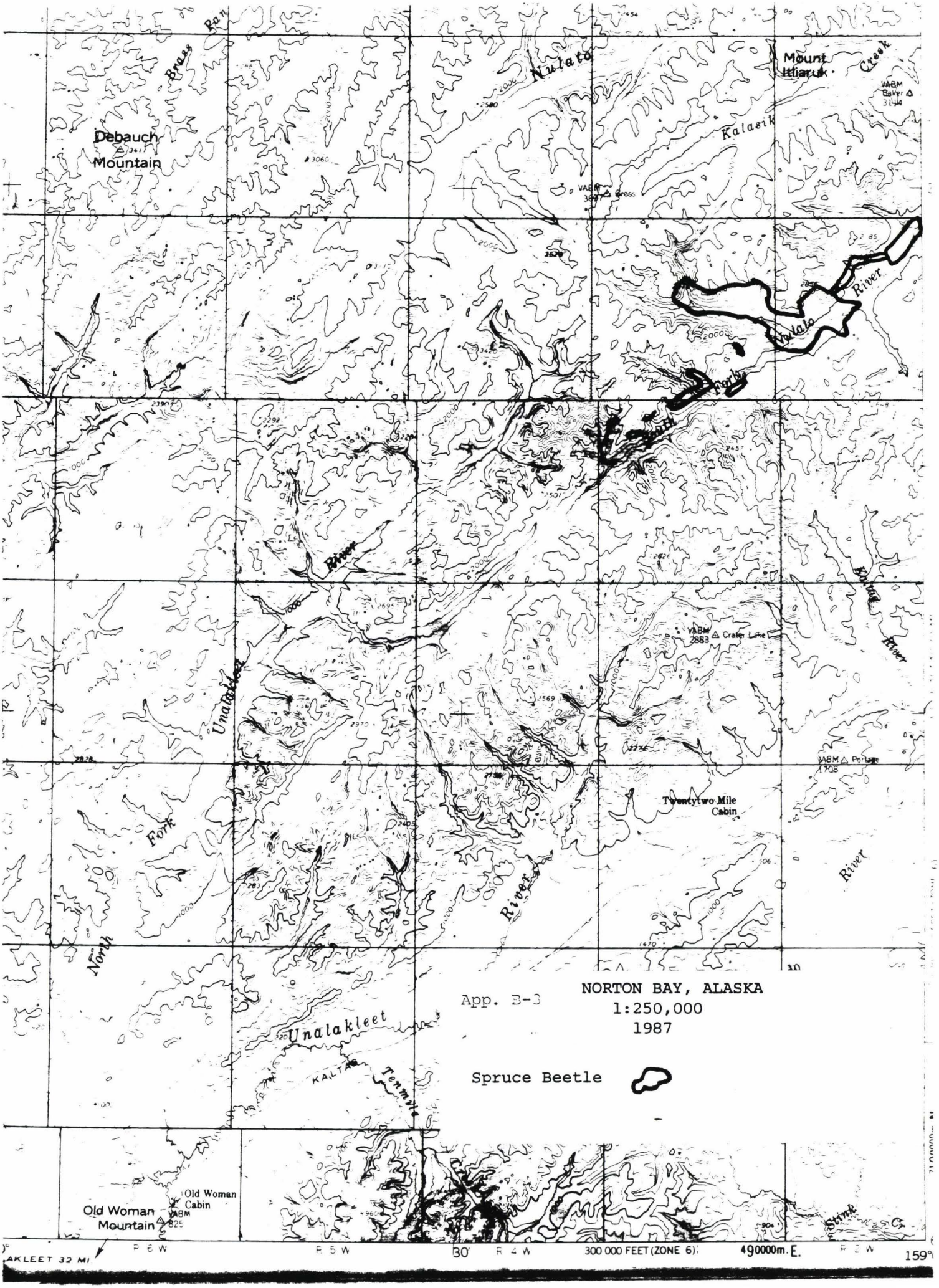
Spruce Beetle

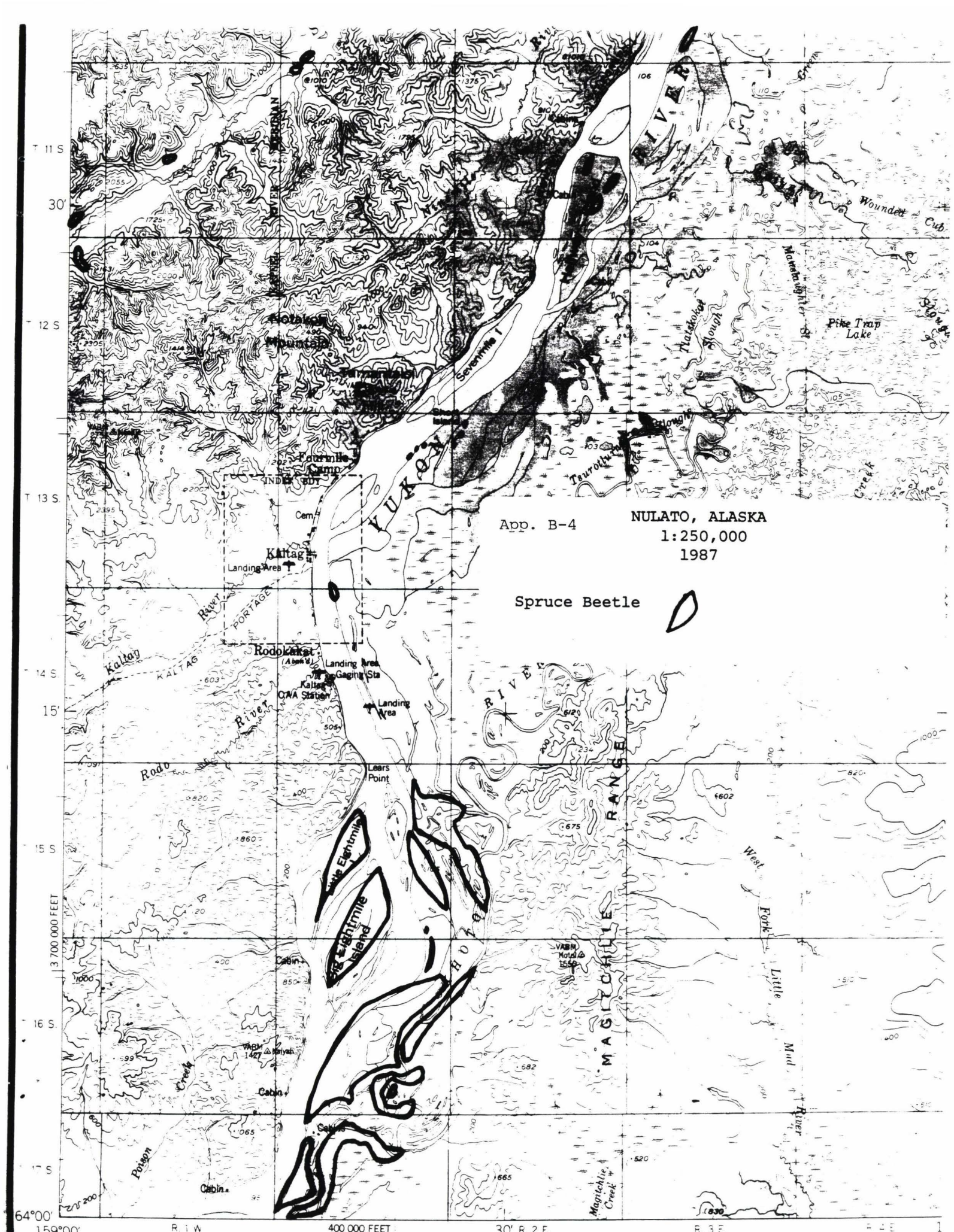
App. B-2

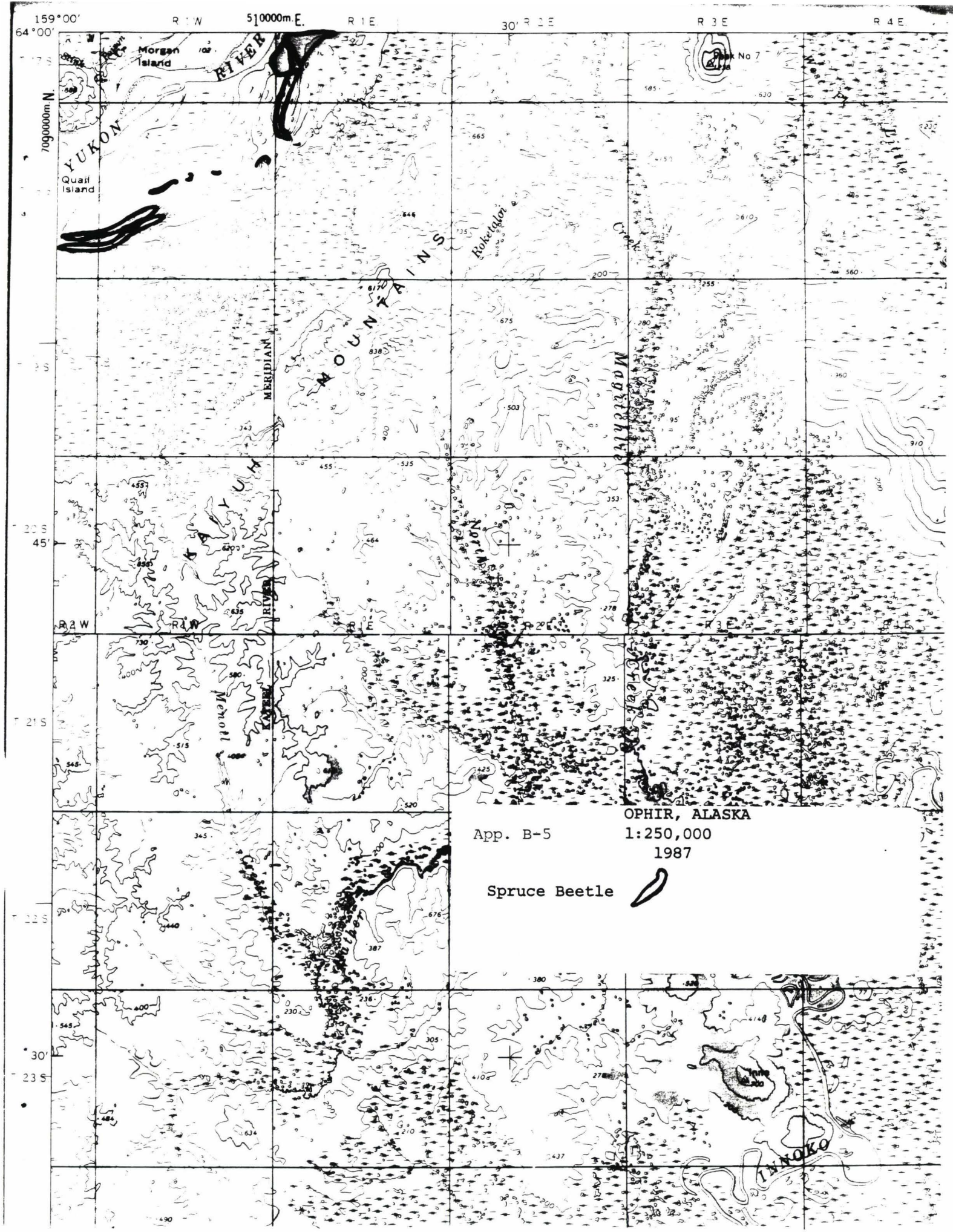
NULATO, ALASKA
1:250,000
1987

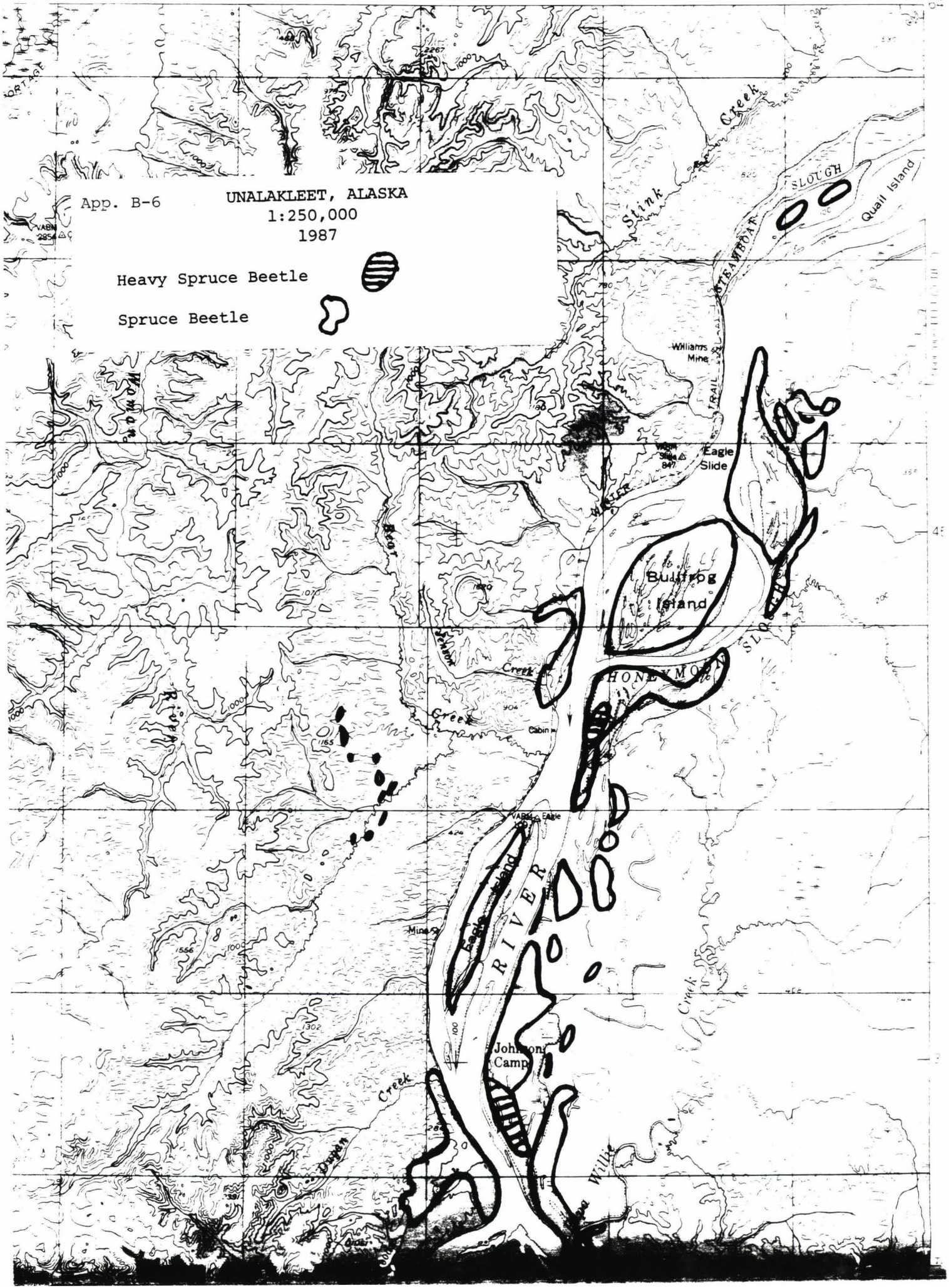
Spruce Beetle

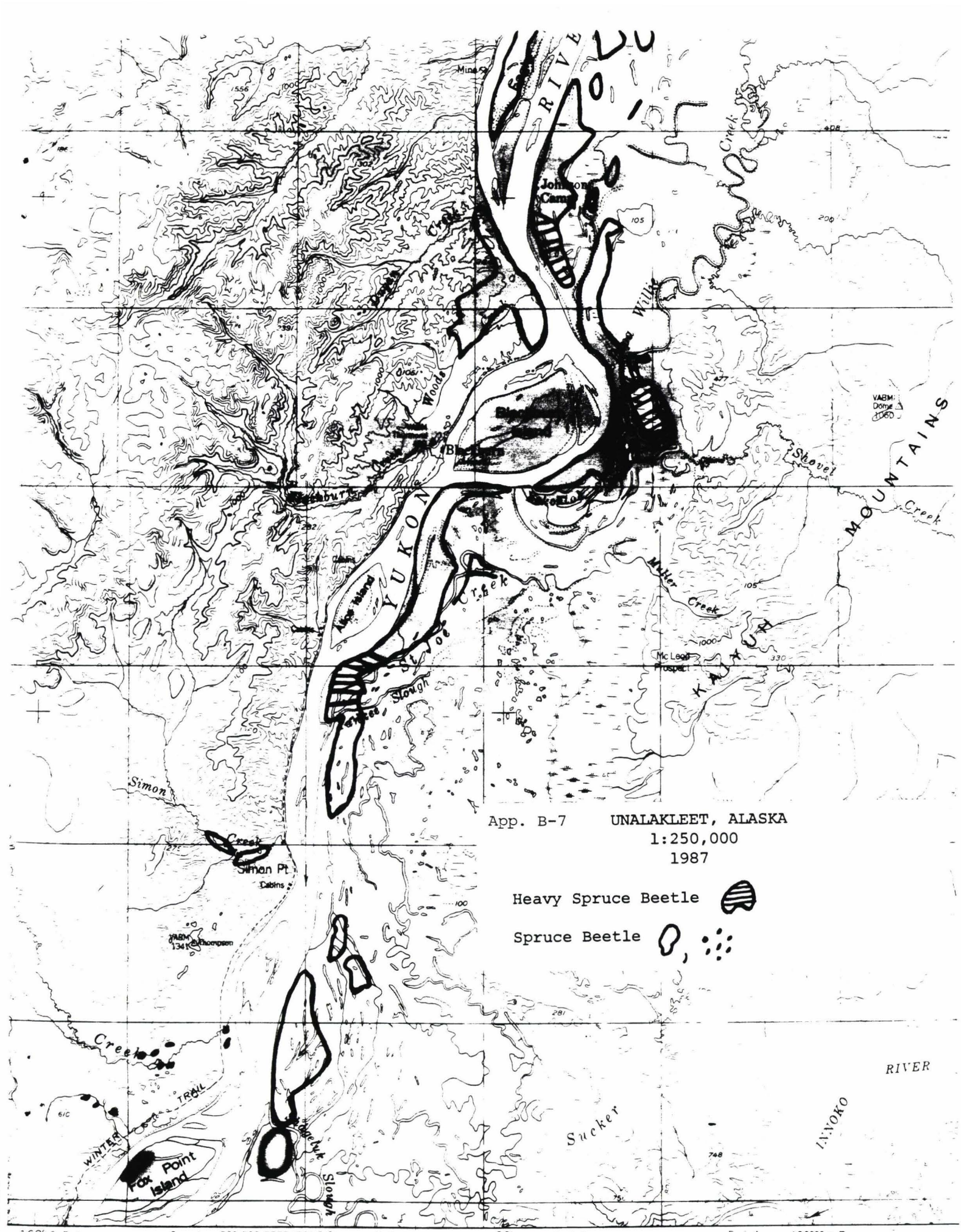



Debauch Mountain
Mount Iliaruk
Kalasik
Nulato
River
Unalakleet
North Fork
Twentytwo Mile Cabin
Old Woman Mountain
Old Woman Cabin
Unalakleet
KALTAG
Tenmyte
Stink Cr
NORTON BAY, ALASKA
1:250,000
1987
Spruce Beetle
App. B-3
AKLEET 32 MI
R 6 W
R 5 W
30'
R 4 W
300 000 FEET (ZONE 6)
490000m. E.
159°


App. B-4
NULATO, ALASKA
1:250,000
1987
Spruce Beetle
YUKON
RIVER
Nulato
Mountain
Rodokakat
Kaltag
Landing Area
Gaging Sta
CAA Station
Rodo
River
KALTAG
PORTAGE
Lears Point
Eightmile Island
Cabin
Poison
Creek
Hoholitna
MAGICHILLIE RANGE
West Fork
Little Mud
River
Magichilie Creek
Pike Trap Lake
Wounded Cub
Nulato Slough
Tsirolthi
Creek
Seventymile
Camp
INDEX
Cem
T 11 S
T 12 S
T 13 S.
T 14 S
T 15 S
T 16 S.
T 17 S
30'
15'
64°00'
159°00'
R. 1 W
400 000 FEET
R. 1 E.
30' R. 2 E.
R. 3 E.
3 700 000 FEET


159°00'
64°00'
510000m.E.
7090000m.N.
R 1 W
R 1 E
30'
R 2 E
R 3 E
R 4 E
T 22 S
45'
T 23 S
30'
T 21 S
Morgan Island
YUKON RIVER
Quail Island
Peak No 7
MOUNTAINS
Roketaloi
Creek
MERIDIAN
KATLYUH
RIVER
Mount
Katlyuh
North
Fork
Middle
Fork
Inna
Lake
INNOKO
OPHIR, ALASKA
App. B-5
1:250,000
1987
Spruce Beetle

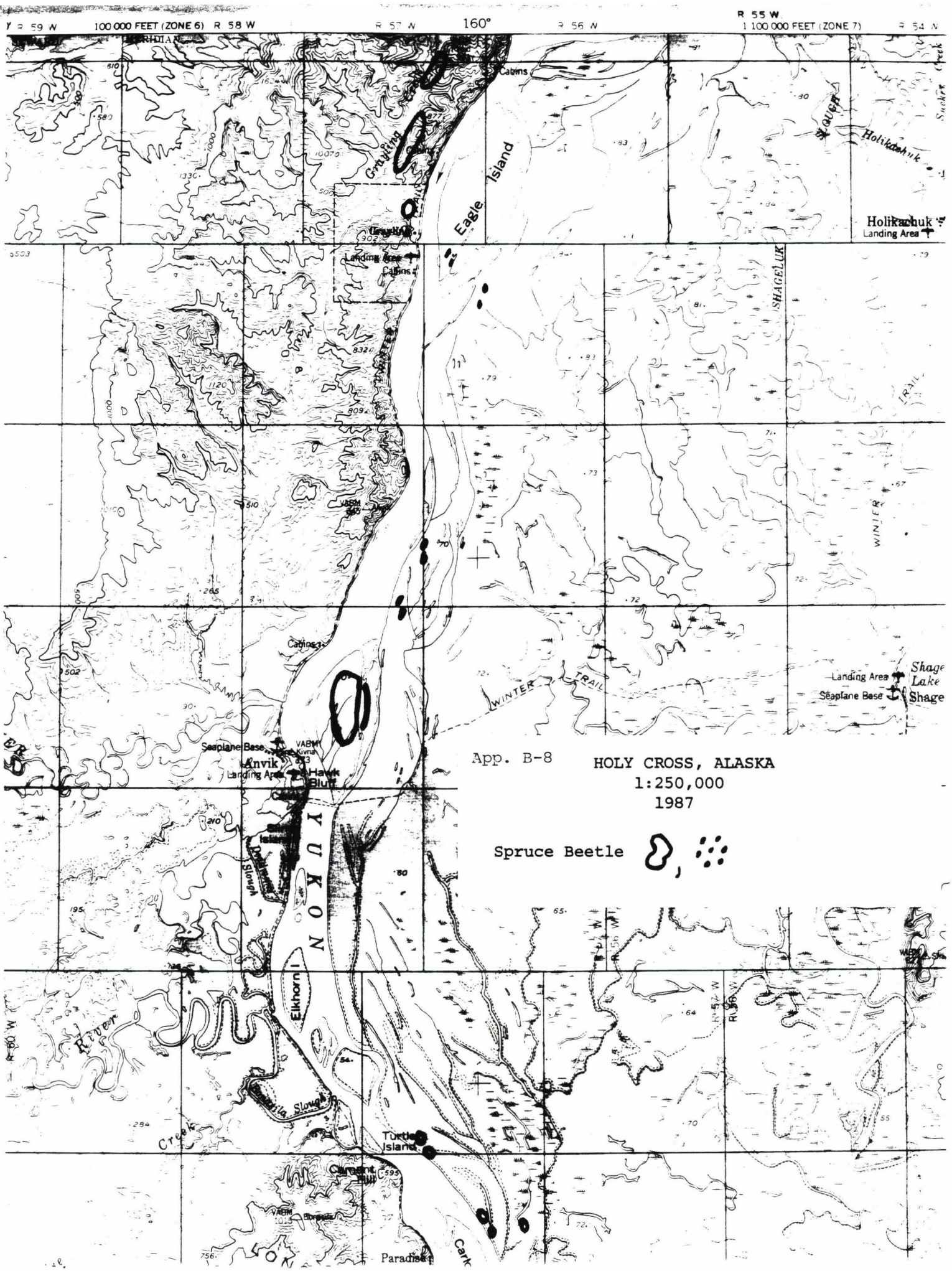

App. B-6
UNALAKLEET, ALASKA
1:250,000
1987
Heavy Spruce Beetle
Spruce Beetle
Stink Creek
SLOUGH
Quail Island
STEAMBOAT
Williams Mine
TRAIL
Eagle Slide
WHEELER
Bullfrog Island
HONEYMOON
Creek
Cabin
Eagle
RIVER
Johnson Camp
Creek
Willie
Creek



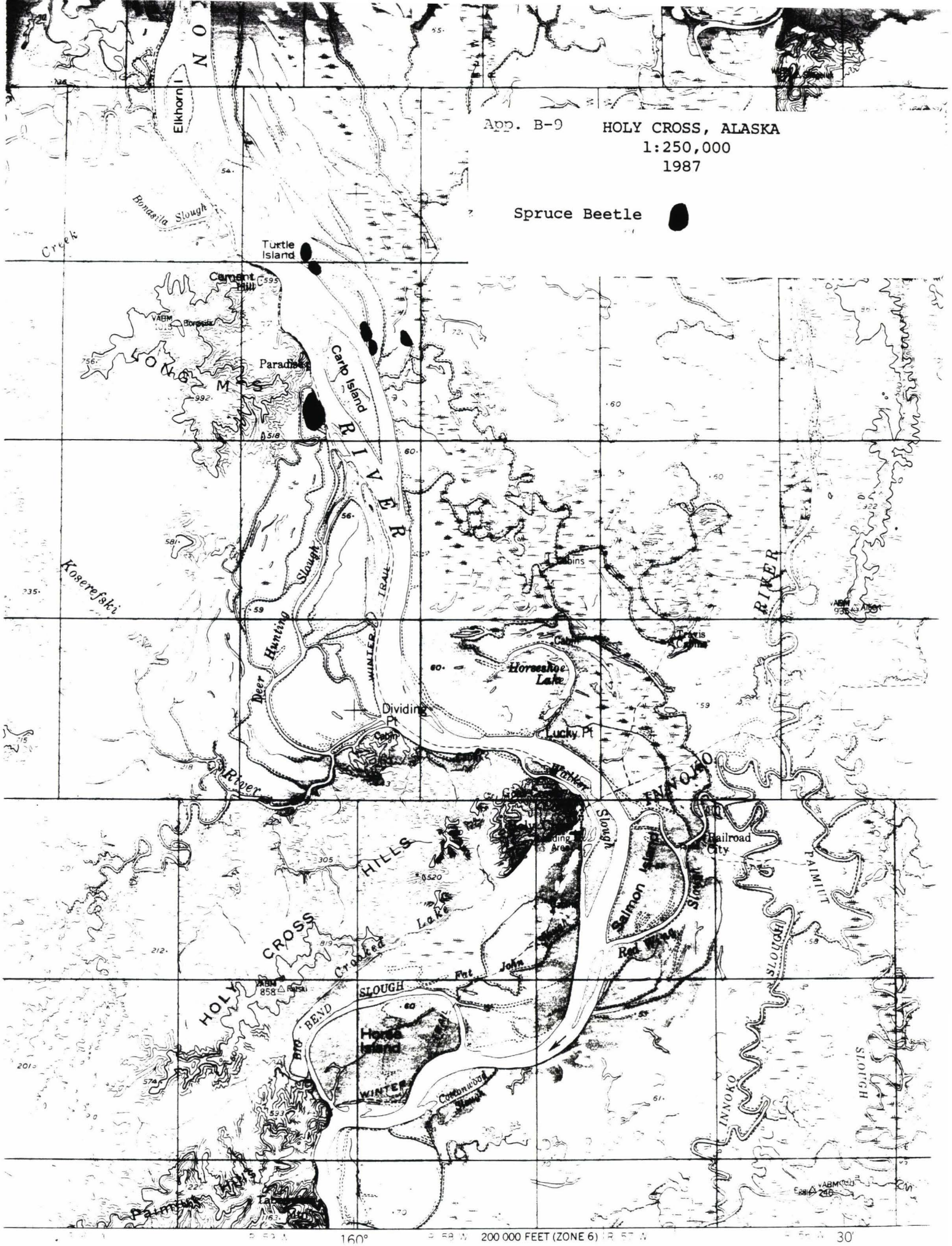
App. B-7 UNALAKLEET, ALASKA
1:250,000
1987

Heavy Spruce Beetle

Spruce Beetle


100 000 FEET (ZONE 6)
R 58 W
R 57 W
160°
R 56 W
R 55 W
1 100 000 FEET (ZONE 7)
R 54 W
Eagle Island
Holikachuk
Landing Area
Cabins
Holikachuk Creek
SHAGELUK TRAIL
WINTER TRAIL
Shage Lake
Landing Area
Seaplane Base
Shage
Seaplane Base
Anvik
Landing Area
Hawk Bluff
YUKON
Elkhorn I.
Turtle Island
Paradise
Clark
App. B-8
HOLY CROSS, ALASKA
1:250,000
1987
Spruce Beetle

App. B-9


HOLY CROSS, ALASKA
1:250,000
1987
Spruce Beetle
Elkhorn I
Bonasila Slough
Creek
Turtle Island
Cement Hill
Paradise
Carp Island
YUKON MTS
YUKON RIVER
Koserefski
Deer Hunting Slough
WINTER TRAIL
Horseshoe Lake
Dividing Pt
Lucky Pt
Parker
Railroad City
Salmon Slough
PAIMIUT SLOUGH
INNOKO SLOUGH
HILLS
CROSS
Crooked Lake
HOLY
SLOUGH
BEND
Horse Island
WINTER
Flat
John
Red Hills
Lake
160°
200 000 FEET (ZONE 6)
30'